Actionable Intelligence for the Warfighter — Achieving Army ISR Net-Centricity Through a Service-Oriented Architecture (SOA)

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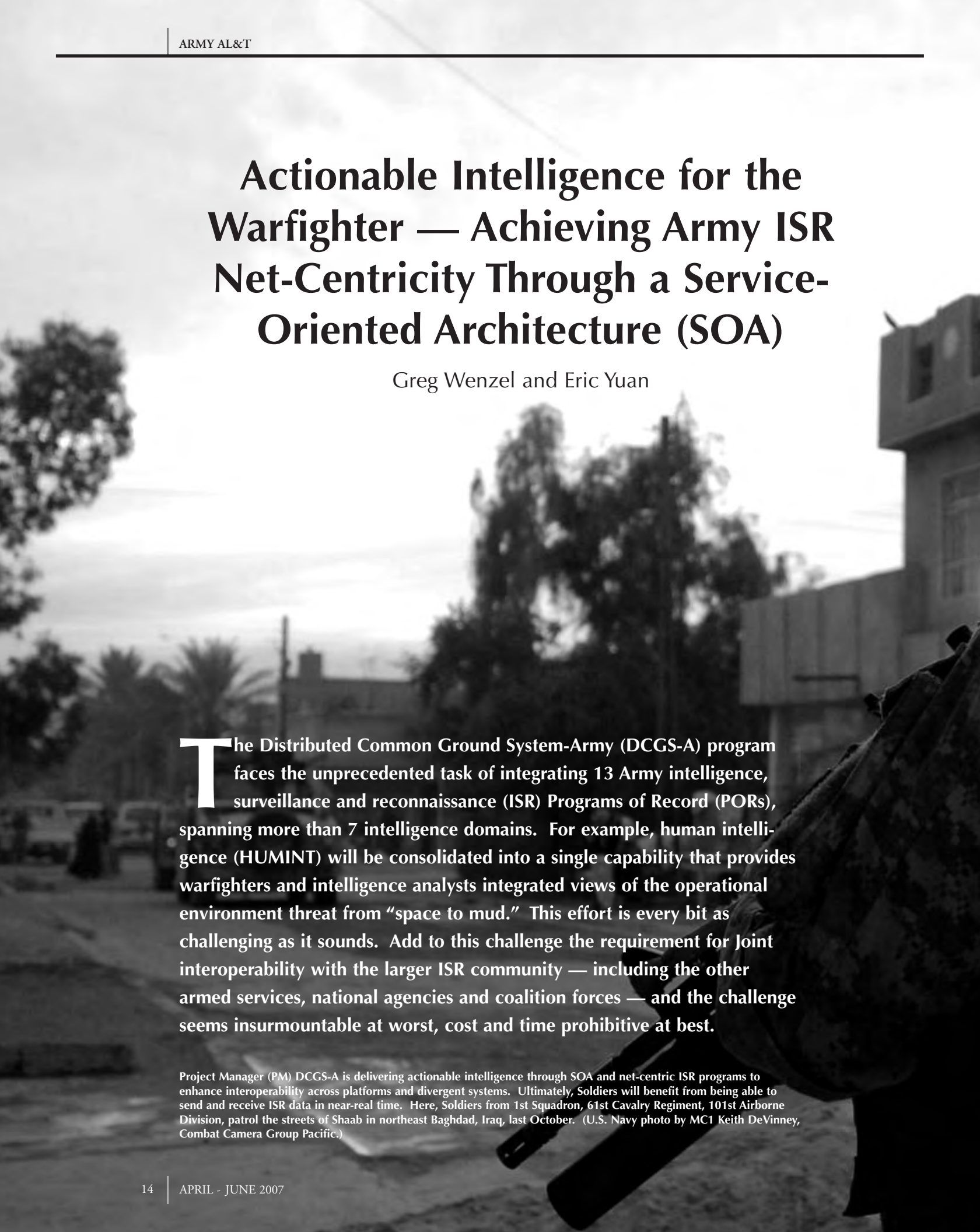


The Distributed Common Ground System-Army (DCGS-A) program faces the unprecedented task of integrating 13 Army intelligence, surveillance and reconnaissance (ISR) Programs of Record (PORs), spanning more than 7 intelligence domains. For example, human intelligence (HUMINT) will be consolidated into a single capability that provides warfighters and intelligence analysts integrated views of the operational environment threat from "space to mud." This effort is every bit as challenging as it sounds. Add to this challenge the requirement for Joint interoperability with the larger ISR community — including the other armed services, national agencies and coalition forces — and the challenge seems insurmountable at worst, cost and time prohibitive at best.

Project Manager (PM) DCGS-A is delivering actionable intelligence through SOA and net-centric ISR programs to enhance interoperability across platforms and divergent systems. Ultimately, Soldiers will benefit from being able to send and receive ISR data in near-real time. Here, Soldiers from 1st Squadron, 61st Cavalry Regiment, 101st Airborne Division, patrol the streets of Shaab in northeast Baghdad, Iraq, last October. (U.S. Navy photo by MC1 Keith DeVinney, Combat Camera Group Pacific.)

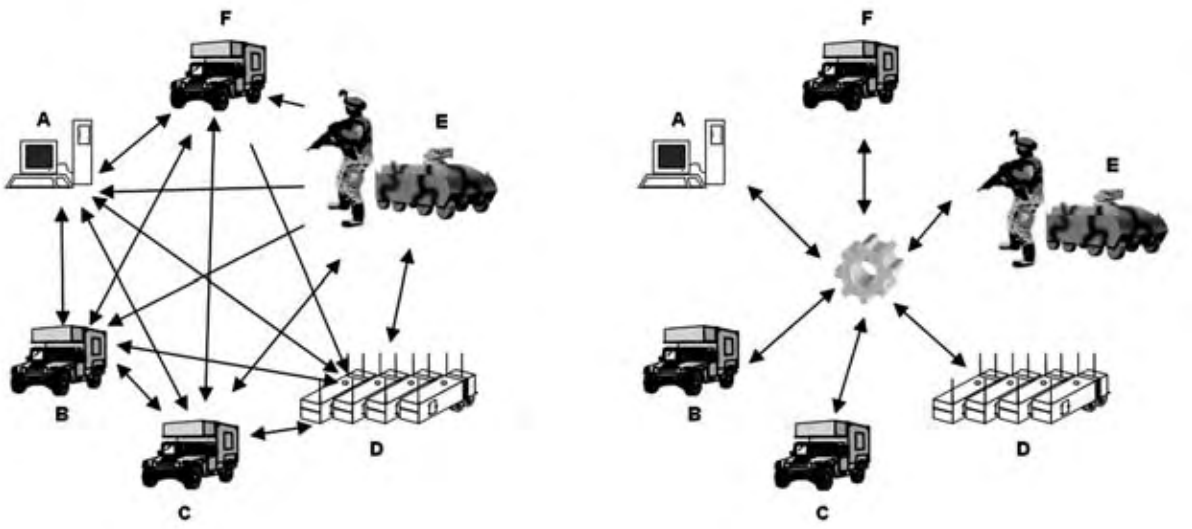
Indeed, the challenge might be insurmountable if the DCGS-A program took a more traditional approach to integration such as platform homogeneity, point-to-point integration or even message-broker middleware. Instead, DCGS-A is employing an SOA approach using Web services to achieve the goal of net-centric ISR systems interoperability.

Traditional Approach Limitations

To exchange information among systems using platform homogeneity, all legacy systems would need to be migrated to a single monolithic technology platform with identical data structures, programming languages and software configurations. This is not only cost prohibitive and time consuming, but is also undesirable because it would adversely impact system performance and degrade adaptability through vendor lock-in. Looking beyond DCGS-A, migrating all ISR community systems to a common technology platform is unrealistic because of the various platform standards already in use and the hundreds of millions of dollars invested to date.

DCGS-A is employing an SOA approach using Web services to achieve the goal of net-centric ISR systems interoperability.

Point-to-point integration involves tying one system to another by writing code that translates messages from the source system into a form that is understandable by the target system and vice versa. Specifically, this



Point-to-Point Integration for POR Systems

Hub-and-Spoke Integration for POR Systems

Figure 1. Traditional Integration Approaches

approach uses the underlying, usually proprietary, Application Programming Interfaces as the access mechanism. This approach is widely considered "tightly coupled" because the interface between the source and target systems is built unique to those two systems. Hence, the integration capability can't be leveraged across other systems. Additionally, whenever the system software and data structures are altered, programmers must change the integration code accordingly. This creates significant cost, maintenance and scalability problems. This scalability issue, which analysts call the "N2 problem," (handling data volume and path issues using sensible defaults and defined target lists) escalates exponentially as new systems are introduced into a network of integrated systems.

> As leveraged information services supplant large monolithic applications, the traditional system boundaries begin to disappear and ISR applications can be dynamically assembled in new ways to support changing missions and immediate commanders' needs.

Using a point-to-point approach, DCGS-A would need to build and maintain 156 unique system interfaces to achieve full integration between the 13 PORs. Elevate this scalability concern to the broader ISR community and this integration approach becomes highly impractical and extremely costly.

A traditional message broker middleware approach resolves the N2 problem by introducing a middleware "hub" that serves as the message-handling intermediary. Instead of communicating with one another using unique "one-off" interfaces, the systems interoperate using publish-subscribe style messages brokered by the centralized middleware hub. This "hub-and-spoke" approach, often referred to as Enterprise Application Integration, is implemented using commercial products such as MQSeries®, Tibco®, Web Logic® and webMethods®. Although effective in well-defined and clearly scoped enterprise settings, this approach is centralized within an enterprise (intra-enterprise), technology-dependent and platform-centric, rather than distributed across enterprises (inter-enterprise), open and net-centric. It offers limited scalability and adaptability that is insufficient for large-scale, cross enterprise, net-centric environments such as DCGS-A and the broader ISR community. These traditional integration approaches are depicted in Figure 1.

Net-Centricity and ISR Transformation

The DCGS-A program is transforming the Tasking, Processing, Exploitation, Dissemination (TPED) Intelligence Cycle, an inherently sequential and platform-centric process, to the new net-centric Tasking, Posting, Processing, Use (TPPU) paradigm. Although TPPU encompasses all TPED functions, it refactors them into a more open, dynamic and leveraged capability, making data available immediately for processing into actionable intelligence. The TPPU vision has some profound architectural implications as follows:

- *Pull Versus Push*. Information flows are no longer just a one-way "push,"

but will be both push and "pull." TPPU systems allow users to selectively retrieve only the data that is of interest to them.

- *Collaboration.* Because "post before process" becomes part of the norm under TPPU, the discrete information provider to information processor to information consumer chain is blurred and the sequential TPED "pipeline" is morphed into a many-to-many collaborative network.
- *System-to-System.* Many traditional ISR "stovepipe" systems architectures were built to support only human-system interfaces, but they now must support system-to-system integration as well. For example, instead of a user querying all systems for data on a regular basis, a Web portal may periodically query available ISR systems on a user's behalf and alert the user of any time-critical intelligence data.
- *Open Services.* In a TPPU environment, as leveraged information services supplant large monolithic applications, the traditional system boundaries begin to disappear and ISR applications can be dynamically assembled in new ways to support changing missions and commanders' immediate needs. The traditional stovepiped systems will give way to a set of net-centric technology services that can be leveraged across the ISR community.

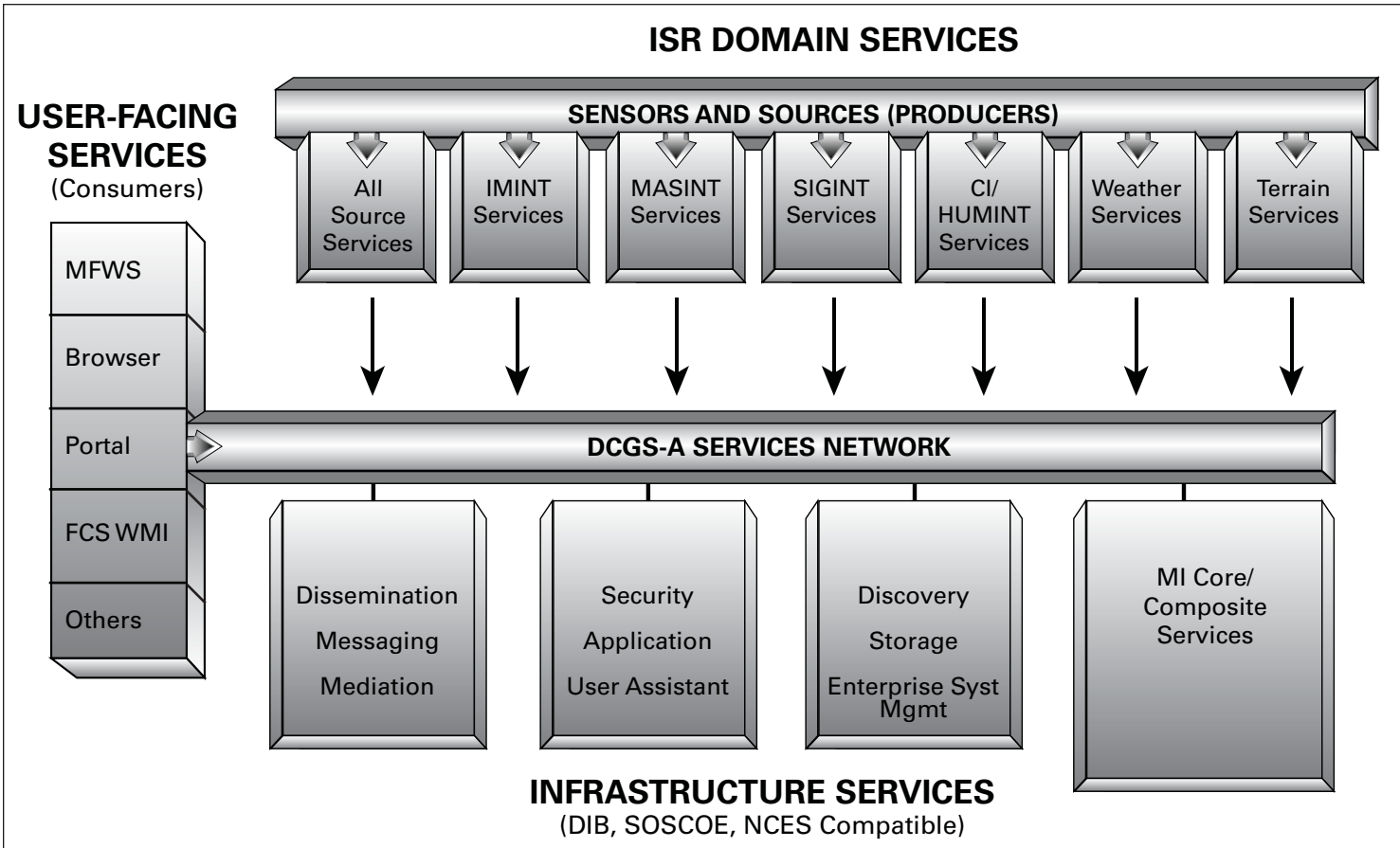
> Once an ISR organization achieves system interoperability by conforming to the interface specification, it gains the benefit of interoperability with all "networked" ISR systems that also conform to the interface specification.

As the Army's next-generation intelligence technology capability provider, DCGS-A is designing around these and other architecture tenets to support the future needs of warfighters and intelligence analysts.

Achieving Net-Centricity

Instead of using simple point-to-point or hub-and-spoke integration, DCGS-A is achieving net-centricity through SOA and Web services by constructing a set of leveraged ISR service interface specifications. These application and data interface specifications provide a layer of

Soldiers like SPC Andrew Ruhlman above are already benefiting from next-generation intelligence technology being developed by PM DCGS-A. New architecture tenets are supporting warfighters and intelligence analysts. Ruhlman, assigned to the 37th Armored Regiment, 1st Brigade Combat Team, 1st Armored Division, maintains radio contact with fellow platoon members during a patrol near Tal Afar, Iraq. (U.S. Air Force photo by SSGT Jacob N. Bailey, 1st Combat Camera Squadron.)



Key:

CI/HUMINT – Counter & Human Intelligence
DIB – DCGS Integration Backbone
FCS WMI – Future Combat Systems Warfighter Machine Interface
IMINT – Imagery Intelligence
MASINT – Measurement and Signals Intelligence
MFWS – Multi-Functional Workstation
NCES – Net-Centric Enterprise Services
SIGINT – Signals Intelligence
SOSCOE – System of Systems Common Operating Environment

Figure 2. DCGS-A SOA Integration Approach

abstraction that allows for system interoperability regardless of the interoperating systems' underlying technology infrastructure, including hardware, software and data structures. These net-centric "over-the-wire" specifications serve to establish the standard formats and protocols that participating systems employ to exchange data and perform services, thereby making the integrating architecture platform-, programming language- and vendor-independent. The interface specifications serve as the DCGS-A SOA's building blocks and are built using Web services-based open standards such as eXtensible Markup Language; Simple Object Access Protocol; and Universal Description, Discovery and Integration.

The DCGS-A program's goal is to achieve interoperability with the broader ISR community, not just among DCGS-A PORs. To this end, the interface specification development effort continually works to be more and more inclusive so that the specification gains the broadest applicability in the ISR community. The specifications define more than 130 ISR services addressing HUMINT, geospatial intelligence, signals intelligence, measurement and signatures intelligence, and all source domains, and incorporates the DIB standards. DCGS-A is currently working with and expanding involvement with other ISR organizations and data standards working groups to improve and evolve the interface specifications. The DCGS-A SOA integration architecture is illustrated in Figure 2.

The advantage of this SOA approach is self-evident. With SOA/Web services, DCGS-A can publish services to the ISR "network" using a standard interface specification and then the decision to interoperate and the effort of integrating is pushed out to ISR community organizations that wish to access those services by "plugging into the

network." This promotes scalability by delegating the integration effort out to the network of ISR organizations. Once an ISR organization achieves system interoperability by conforming to the interface specification, it gains the benefit of interoperability with all "networked" ISR systems that also conform to the interface specification. A single integration effort reaps the benefits of all the systems networked via the interface specification — Metcalfe's Law. Metcalfe's Law states that the value of a telecommunications network is proportional to the square of users of the system (n2). First formulated by Robert Metcalfe in regard to the Ethernet, his law explains many of the network effects of communication technologies and networks such as the Internet and World Wide Web. Users gain additional information sources through unanticipated data providers as they are published and plugged into the net. This is the essence of net-centricity. The DCGS-A set of service interface specifications is the critical enabler for the rapid integration of systems into a DCGS-A ISR services "marketplace" that will significantly benefit the Army and the ISR community at large.

DCGS-A is aggressively examining operational scenarios and systems architecture in applying modular force structure, TPPU and service-oriented concepts to address the operational, acquisition and organizational aspects of Army ISR force transformation.

From an acquisition perspective, the SOA approach also provides great benefits and cost savings. Once the initial capability is in place, the DCGS-A program can more easily enhance, or even entirely replace, legacy systems and deliver greater capability to warfighters with no adverse impact on operational continuity. The DCGS-A Web services-based interface specification driven approach can reduce the integration effort by an order of magnitude allowing a much more rapid "time-to-capability" for warfighters. Interoperability is achieved through compliance with a community-endorsed, open standards-based set of interface specifications, which substantially reduces the number of interfaces required to develop, maintain and achieve a critical element in the evolution to net-centricity.

Net-Centricity Involves More Than Technology

ISR effectiveness depends on technology and on processes, people and organizations. Working with the U.S. Army Training and Doctrine Command Capability Manager, DCGS-A PORs and other intelligence community subject matter experts, DCGS-A is aggressively examining operational scenarios and systems architecture in applying modular force structure, TPPU and service-oriented concepts to address the operational, acquisition and organizational aspects of Army ISR force transformation. DCGS-A is not simply trying to reuse existing POR capabilities, but is striving to integrate those capabilities in innovative ways to support future ISR missions.

Leading commercial organizations, including Amazon®, eBay®, Google™, Dell™ and countless others, have unequivocally proven the net-centric power of interface specification-driven interoperability using SOA and Web services technologies. The Army and the larger ISR community can apply these same technologies to achieve similar net-centric transformational improvements. At PM DCGS-A, we believe that we owe it to our combatant commanders and their Soldiers to capitalize on technologies that are transforming the world today.

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